U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE

MEMORANDUM FOR: Distribution

FROM: W/OPS2 — John Van Kuren/s/ 04/09/2007

SUBJECT: Interim Operational Acceptance Test (OAT) Report for the Advanced Weather Interactive Processing System (AWIPS) Multi-Protocol Label Switching (MPLS) Wide Area Network (WAN).

Attached for your information is a copy of the subject report, which describes field tests of the AWIPS MPLS WAN undertaken to evaluate the readiness of the system for national deployment.

The field tests of the AWIPS MPLS WAN began on Monday, January 8, 2007, and were concluded on Friday, February 9, 2007. The OAT was conducted at the following National Weather Service sites:

- Weather Forecast Office (WFO) Aberdeen, SD (ABR);
- WFO Grand Forks, ND (FGF);
- Central Region Headquarters, Kansas City, MO (BCQ);
- Missouri Basin River Forecast Center (RFC), Pleasant Hill, MO (KRF);
- North Central RFC, Chanhassen, MN (MSR); and
- AWIPS Network Control Facility, Silver Spring, MD (NCF).

Upon review of the results of the field tests, the Test Review Group recommended the AWIPS MPLS WAN not be nationally deployed due to critical deficiencies in the proposed network. A follow-on OAT will be conducted to evaluate the remedial actions taken to correct these deficiencies.

Comments and questions concerning this report may be directed to the MPLS OAT Director, Ken Stricklett (W/OPS24) at 301-713-0326 x113, e-mail ken.stricklett@noaa.gov or Mary Buckingham (W/OPS24) at 301-713-0326 x137, e-mail mary.buckingham@noaa.gov.

Attachment

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INTERIM
AWIPS MPLS OAT REPORT

March 2007

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service/Office of Operational Systems
Field Systems Operations Center/Test and Evaluation Branch

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List of Attachments

Acronyms

AWIPS	Advanced Weather Interactive Processing System
CE	Customer Edge
CRH	NWS Central Region Headquarters
FMK	Field Modification Kit
FR	Frame Relay
FSOC	Field Systems Operations Center
HIC	Hydrologist-In-Charge
IT	Information Technology
ITSO	Information Technology Security Office
LF	Lead Forecaster
MHS	NCF Message Handling System
MIC	Meteorologist-In-Charge
MNS	Sprint Managed Network Services
MPLS	Multi-Protocol Label Switching
NCEP	National Centers for Environmental Prediction
NOAA	National Oceanic and Atmospheric Administration
NOC	NOAAnet Operational Center
NWS	National Weather Service
NWSTG	NWS Telecommunication Gateway
OAT	Operational Acceptance Test
OCIO	Office of the Chief Information Officer
CIO14	Telecommunications Infrastructure Branch
OPS24	Office of Operating Systems, Test and Evaluation Branch
OST	Office of Science and Technology
OST31	Office of Science and Technology, Analysis Branch
PAMS	Product Availability Monitoring System
PE	Provider Edge
POC	Point-of-Contact
PVC	Permanent Virtual Circuits
RFC	River Forecast Center
RTMS	AWIPS Real Time Monitoring System
SEC	System Engineering Center
SLA	Service Level Agreement
SOP	Standard Operating Procedures
TOC	Telecommunication Operations Center
TRG	Test Review Group
TTR	Test Trouble Report
VRF	Virtual Routing and Forwarding
VPN	Virtual Private Network
WAN	Wide Area Network
WFO	Weather Forecast Office
WSH	National Weather Service Headquarters

Interim AWIPS MPLS OAT Report

1. Introduction

An Operational Acceptance Test (OAT) of a proposed Advanced Weather Interactive Processing System (AWIPS) Multi-Protocol Label Switching (MPLS) Wide Area Network (WAN) was undertaken to evaluate the operational readiness of the system. Most network services within the National Oceanic and Atmospheric Administration (NOAA) are slated for consolidation to a single network, NOAAnet. The AWIPS MPLS WAN will be implemented as a component of NOAAnet. This interim report summarizes the activities conducted to date and the recommendations of the Test Review Group (TRG) regarding the national migration of the AWIPS communication network to NOAAnet.

A detailed discussion of the OAT strategy, objectives, and evaluation criteria is provided in the OAT Plan, August 2006, as amended, which can be obtained at:

http://www.weather.gov/ops2/ops24/documents/awips_docs.htm.

The OAT Plan stipulates a 30-day evaluation of a pilot network comprised of AWIPS sites located in the NWS Central Region. The following sites were included in these field tests:

- Weather Forecast Office (WFO) Aberdeen, SD (ABR);
- WFO Grand Forks, ND (FGF);
- Central Region Headquarters, Kansas City, MO (BCQ);
- Missouri Basin River Forecast Center (RFC), Pleasant Hill, MO (KRF);
- North Central RFC, Chanhassen, MN (MSR); and
- AWIPS Network Control Facility, Silver Spring, MD (NCF).

The field tests of the pilot network initially began on September 18, 2006. However, the OAT was suspended on September 25, due to instabilities in network communications discovered during these initial tests; and the network was turned over to the systems engineers for troubleshooting.

A proposed workaround was developed and a Test Readiness Review was held on January 4, 2007, to consider whether the OAT should be resumed. The TRG determined that the proposed workaround was acceptable for national deployment and recommended that the OAT be resumed. Field tests were restarted on January 8, 2007, and were concluded on February 9, 2007.

A meeting of the TRG was convened on February 22, 2007, to review the OAT activities and to consider the proposed national migration of the AWIPS communications network to NOAAnet. The members of the TRG were of a consensus that the proposed network had not met all

operational criteria and, therefore, it should not be nationally deployed for AWIPS communications at this time. The OAT was suspended until the critical deficiencies identified during the OAT are corrected and the remedial actions taken to correct the deficiencies can be tested.

2. OAT Evaluation Criteria

The OAT evaluation criteria, as stated in Section 1.5 of the OAT Plan, follow:

- The AWIPS System Modification Notes (Mod Notes) for installation of network hardware must provide accurate and complete instructions.
- The Field Modification Kits (FMKs) must contain all required cables and associated hardware for installation of NOAAnet equipment.
- Test Trouble Reports (TTRs) assigned Impact 1 or 2 must be closed, and any workarounds must be fully documented.
- All measures of network communications performance for the MPLS WAN must equal or exceed those obtained for the existing frame relay (FR) WAN, and the measured network communications performance must be consistent with the Sprint Service Level Agreement (SLA).

2.1 Mod Notes

The Mod Notes did not meet the evaluation criteria—FAILED.

2.1.1 Discussion

The Mod Notes required for installation of the NOAAnet equipment were evaluated at ABR, FGF, BCQ, KRF, and MSR. Site visits were conducted at MSR and FGF to witness the hardware installation. The Mod Notes were revised and subsequently released for the installations at KRF, FGF, and BCQ. The installations at KRF, FGF, and BCQ did not identify further revisions and the Mod Notes were presumed correct.

The hardware currently proposed for deployment to the AWIPS sites, however, has been changed since the Mod Notes were evaluated. These changes affect the equipment installations at all AWIPS sites. The Mod Notes need to be revised and tested at not less than one WFO site, one RFC site, and one National Center for Environmental Predication (NCEP) site prior to migration of the AWIPS communications network to NOAAnet.

2.2 Field Modification Kits

The FMKs did not meet the evaluation criteria—FAILED.

2.2.1 Discussion

The FMKs required for installation of the NOAAnet equipment were evaluated at ABR, FGF, BCQ, KRF, and MSR. Site visits were conducted at MSR and FGF to witness the hardware installation.

The hardware currently proposed for deployment to the AWIPS sites has been changed since the FMKs were evaluated. These changes affect the equipment installations at all AWIPS sites. The FMKs need to be revised and tested at not less than one WFO site, one RFC site, and one NCEP site prior to migration of the AWIPS communications network to NOAAnet.

The issue of proper cable labels was raised during field tests of the FMKs and has not been resolved. The FMKs are being prepared under contract with Raytheon Technical Services (RTS). The completion of this task, including the cable labels, is awaiting receipt of a final equipment inventory from the Telecommunications Infrastructure Branch (CIO14), Office of the Chief Information Officer (OCIO).

2.3 Test Trouble Reports

The TTRs met the evaluation criteria—PASSED.

2.3.1 Discussion

There were no open TTRs at the conclusion of the field tests.

2.4 Network Performance

Network performance did not met the evaluation criteria—FAILED.

2.4.1 Discussion

Network performance considered two areas: 1) product throughput; and 2) support services. The evaluation criteria for product throughput were met; however, support services did not meet the evaluation criteria, thus network performance failed to meet the evaluation criteria overall.

Product Throughput: Product throughput was evaluated by measurement of two parameters: 1) product latency; and 2) product success rate. Data obtained during the OAT were compared with baseline performance data obtained in July/August 2006 and data obtained at two control sites, WFO Pittsburgh, PA (PBZ) and WFO Little Rock, AR (LZK), concurrent with the OAT. An analysis of the product throughput data is discussed in Attachment A.

No significant difference was measured between the product success rates for the baseline evaluation and OAT. A reduction in product latency from the baseline data was noted for network traffic from the WFO sites to the NCF for both the OAT sites and control sites. A reduction in product latency was also noted during the OAT for network traffic from the NCF to the OAT sites; however, there was no corresponding reduction in product latency for network traffic from the NCF to the control sites. These results demonstrate the product throughput of the MPLS WAN is on par with the existing FR WAN and there is no reduction in the product throughput using NOAAnet.

It is not clear the apparent improvement in product latency can be solely attributed to the MPLS WAN. Two factors may have contributed to improved performance: 1) The weather was exceptionally mild and the volume of network traffic was low during the OAT; and 2) the OAT sites have undergone significant changes since the baseline data were obtained. Specifically, additional data servers (DX) were installed at all sites and the AWIPS application software was upgraded to OB7.1 at ABR, FGF, MSR, LZK, and KRF and to OB7.2 at PBZ and BCQ. Most of the product latency is due to the message handling rather than network bandwidth limitations; and, it thus seems likely, the changes in the system hardware and application software might have contributed to improved performance. It should also be noted the apparent improvements in product latency noted in Attachment A are of the order of the expected uncertainty in the AWIPS clock. A more thorough treatment of the data would require careful examination of the uncertainty of the AWIPS clock, which is beyond the scope of the OAT.

Support Services: There was an extended network outage on February 5 during scheduled maintenance of the Cisco 7606 customer edge router located in the primary AWIPS NCF. The time-line for the outage is provided in Attachment B. The time required to complete the maintenance action was estimated to be 10 to 15 min. Network services were, however, interrupted for approximately 2 1/2 hrs. Network services were degraded during the outage to the extent that NCF staff placed MSR and KRF on the FR WAN. ABR and FGF remained on ADTRAN backup system throughout the outage. It may be further noted the scheduled maintenance was not completed during the outage and the router was returned to its initial configuration.

The root cause of the extended outage appears to have been human error: The Sprint operator completing the maintenance action did not follow standard Sprint operating procedures and may not have been fully familiar with the Cisco 7606 router. While human error cannot be eliminated, safeguards must be built into the system to reduce the risk of catastrophic system failure due to such errors. The MPLS network must be hardened by the addition of redundant circuits at critical AWIPS sites, the OCIO must establish rigorous operating procedures, and diligent oversight of contract and NWS personnel must be demonstrated prior to the use of NOAAnet for AWIPS communications.

Had such an outage occurred after national deployment of the AWIPS MPLS WAN, the entire AWIPS WAN communications network would have been down for 2 1/2 hrs. National deployment of the AWIPS MPLS WAN at this time represents a significant risk of a loss of services to a critical NWS operational system.

3. The Recommendations of the TRG

The TRG met on February 22 to review the OAT activities and to consider whether the AWIPS communications network should migrate to NOAAnet. The recommendations of the TRG included the following:

- Suspend the OAT;
- Consider new AWIPS requirements;
- Develop test facilities for AWIPS communications; and
- Perform a critical evaluation of ADTRAN.

3.1 OAT Suspension

The members of the TRG were of a consensus the system had not been demonstrated to be operational and, therefore, it should not be nationally deployed for AWIPS communications at this time. The TRG suspended the OAT until such time that the critical deficiencies identified during the OAT are corrected and the remedial actions taken to correct these deficiencies can be tested.

The critical deficiencies identified include the following:

- The loss and/or degradations of services to AWIPS sites during planned maintenance outages of the firewalls and edge routers;
- The apparent lack of standard operating procedures (SOP) to ensure that the high port availability requirements of AWIPS sites is satisfied during planned maintenance outages and/or the lack of adequate oversight to ensure that SOP are strictly followed; and
- The need to revise and field test the Mod Notes and FMKs at WFO, RFC, and NCEP sites.

3.2 New AWIPS Requirements

The TRG recommended the following be considered as new AWIPS requirements:

- AWIPS requires that during routine maintenance activities on the MPLS edge routers, there shall be no operational downtime and no degradation to operational WAN performance, at the affected sites(s).

- The primary NCF and the backup NCF must be supported by redundant routers and circuits. The routers and circuits are to be configured to enable load sharing during normal operations, automatic fail-over during unscheduled outages, automatic fail-back during recovery from unscheduled outages, and administrative routing of network traffic through one router and circuit during planned maintenance outages.

3.2.1 Discussion

A Juniper SSG 550 router/firewall was initially proposed to replace the Larscom MUX at WFO, RFC, and NCEP sites. The rational for proposing this configuration, rather than redundant routers, was the Larscom MUX was a single point of failure and it was being replaced by a single point of failure. However, the Larscom MUX is maintenance-free while the Juniper router requires periodic upgrades. The proposed network did not adequately consider the impact of maintenance outages on service availability.

CIO14 held a technical interchange meeting (TIM) on Thursday, March 8, to discuss remediation of the problems discovered during the OAT. A more robust network was proposed at the TIM to address these issues. The CIO14 proposal included redundant routers and circuits at the primary NCF and the backup NCF and redundant routers at all RFC sites.

3.3 AWIPS Communications Test Facilities

The TRG recommended the development of dedicated test facilities for AWIPS communications.

3.3.1 Discussion

There is a clear need to develop adequate test facilities to support the further development of AWIPS communications. The AWIPS MPLS WAN project has been hampered by the lack of test facilities. The extended period required for troubleshooting was due, in part, to critical weather days, holiday moratoriums, and the difficulties of coordinating tests between widely separated sites. The strategy of field testing an unproven network during the OAT was only undertaken because there are no adequate test facilities for AWIPS communications. The initial field tests were suspended due to an incompatibility between the message handling system (MHS) application and the firewall. This incompatibility would have been more properly identified during testbed evaluations of the proposed network. The lack of adequate test facilities imposed increased risk to NWS operations.

3.4 ADTRAN Evaluation

The TRG recommended a critical evaluation of the use of ADTRAN as a backup system for AWIPS communications.

3.4.1 Discussion

The volume of network traffic has increased dramatically since ADTRAN was implemented as a backup system for the FR WAN. That the NCF was required to place MSR and KRF on the FR WAN to recover the required system performance during the outage is of concern, and suggests that ADTRAN is bandwidth limited and will not fully support AWIPS communications at sites with high volumes of network traffic. The ADTRAN backup system should be carefully examined to ensure that AWIPS communications requirements are fully supported.

CIO14 has proposed the ADTRAN backup system for use during maintenance of the Juniper routers at the WFO sites. The existing ADTRAN circuits at WFO sites with more than two radars will be augmented by the addition of ADTRAN circuits to handle the higher traffic volume at those sites. The currently proposed redundant routers at RFC sites should reduce the risk that a RFC site would be solely dependent on the ADTRAN backup system to an acceptable level.

4. Follow-on OAT Activities

The following actions must be taken prior to national deployment of the AWIPS MPLS WAN:

1. Develop and fully document SOP for planned maintenance outages and unplanned outages at AWIPS sites. The proposed AWIPS SOP are to be submitted to the AWIPS Configuration Control Board (ACCB) for approval. (ACTION-CIO14)
2. Redesign the proposed MPLS network to meet the new AWIPS requirements, including the implementation of a redundant routers and circuits at the primary NCF and the backup NCF. (ACTION-CIO14)
3. Complete a Critical Design Review (CDR) of the AWIPS MPLS WAN, including the new AWIPS requirements. (ACTION-CIO14)
4. Complete the FMKs, including the cable labels. (ACTION-CIO14, RTS)
5. Field test the Mod Notes and FMKs at not less than one WFO, one RFC, and one NCEP prior to national deployment of the AWIPS MPLS WAN. (ACTION-OPS24, CIO14)
6. Field test the proposed AWIPS SOP for fail-over due to an unplanned outage, fail-back during the recovery from an unplanned outage, and a planned maintenance outage. These tests are to be conducted at the AWIPS NCF, a WFO site, and a RFC site and may be coordinated with the planned role-out of the AWIPS MPLS WAN. (ACTION-OPS24, CIO14, NCF)

A follow-on OAT Plan will be prepared to provide a detailed description of the required tests and a schedule for completion of the tests.

The OAT is intended to test the actual systems proposed for national deployment. The OAT should, therefore, not be resumed until the AWIPS MPLS WAN has been subjected to a CDR and any critical issues identified by the CDR are resolved.

Attachment A Analysis of Network Throughput

A.1 Methods

The evaluation of network throughput is based on data obtained using the Product Availability Monitoring System (PAMS). PAMS was used during the OAT to monitor end-to-end communications between the AWIPS field sites ABR, FGF, BCQ, PBZ and LZK, and the AWIPS NCF. The sites ABR, FGF, and BCQ were OAT sites included in the pilot network and the sites PBZ and LKZ were control sites. ABR, FGF, PBZ, and LZK are WFO sites and BCQ is the Central Region Headquarters. The sites were monitored for two 30-day periods: 1) baseline performance data were obtained in July/August 2006; and 2) the OAT was conducted in January/February 2007.

PAMS monitors end-to-end network communications at the Internet Protocol (IP) layer: Each product sent over the AWIPS network is logged on both the sending and receiving servers; and the log entries are queried to provide diagnostic information regarding network communications. Each log entry contains a time stamp, product identifier, and World Meteorological Organization (WMO) header that may be used to uniquely identify the product. The time stamp is referenced to the system clock, which is synchronized across the network and has a stated uncertainty goal of ± 1 second.

PAMS relies on an off-line analysis of the product logs: The logs are "pushed" from the AWIPS sites onto a server located at NWS Headquarters (WSH). The logs are then "pushed" or "pulled" onto a local machine for analysis. These methods place very little burden on network communications and are relatively noninvasive.

The figures-of-merit considered for the OAT are the product success rate, R, and the average product latency, $\overline{\Delta t}$. The success rate, expressed in percent, is given by the following equation,

$$R = \frac{n_r}{n_s} 100,$$

where n_s is the number of products sent in a given time interval and n_r is the number of the products received. The product latency is given by the following equation,

$$\Delta t_i = t_{ri} - t_{si},$$

where t_{si} is the time that product i was sent and t_{ri} is the time the product was received. The time averaged latency is given by

$$\overline{\Delta t} = \frac{1}{n_r} \sum_i \Delta t_i.$$

A.2 Product Success Rate

The baseline success rate data for network traffic from the NCF to the field sites and for network traffic from the field sites to the NCF are summarized in Tables A-3 and A-4, respectively. The

figures shown in the tables are the daily average success rates expressed in percent. Data are presented for a total of 30 days; however, PAMS data were not available between the dates of July 27 and August 3 and the baseline dates are not sequential.

The success rate data obtained during the OAT for network traffic from NCF to the field sites and for network traffic from the field sites to the NCF are summarized in Tables A-5 and A-6, respectively. It should be noted that the PAMS data were not available on January 11 for all sites and for January 11 through January 16 for BCQ.

The network utilization of BCQ is atypical of a WFO site. The network traffic from NCF to BCQ was essentially identical to the WFO sites; however, Tables A-4 and A-6 indicate that network traffic from BCQ to NCF was intermittent during both the baseline evaluation and OAT. Indeed, the total traffic volume from BCQ to NCF was less than 1000 products per month while the other sites averaged over 150,000 products per month. The ratio of outgoing traffic to incoming traffic for WFO sites was approximately 2 to 1; and, since the bandwidth utilization is the sum of incoming and outgoing traffic, these observations suggest that the bandwidth utilized by BCQ was approximately 1/3 of the WFO sites. For these reasons, the product success rates for traffic from BCQ to NCF will not be considered and the data obtained for traffic from NCF to BCQ will be treated separately.

Univariant analysis of variance (ANOVA) of the data was performed to test for significant differences between the data sets.

The ANOVA results for the baseline product success rate data suggests these data are representative of a single distribution—there was no significant difference between the success rates for traffic from NCF to the WFO sites and for traffic from the WFO sites to NCF during the baseline evaluation.

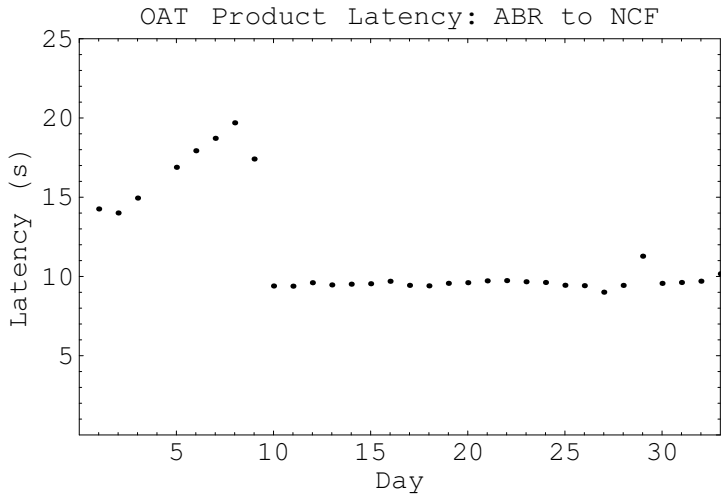
Likewise, the ANOVA results for the OAT product success rate data suggests these data are representative of a single distribution—there was no significant difference between the success rates for traffic from NCF to the WFO sites and for traffic from the WFO sites to NCF during the OAT.

Finally, an ANOVA evaluation of the data was performed to test for differences between the baseline data and the OAT data. The results of this analysis suggest that there is no significant difference between the product success rates obtained during the baseline evaluation and the OAT.

Table A-1: Average Product Success Rates.

	R (%)
NCF to Sites Baseline	99.87
Sites to NCF Baseline	100
NCF to Sites OAT	99.92
Sites to NCF OAT	100
NCF to BCQ Baseline	100
NCF to BCQ OAT	100

Figure A-1: Product latency data for network traffic from ABR to NCF obtained during the OAT. The data shown for days 1 through 9 suggest that the system clock at ABR was not properly synchronized with the AWIPS reference clock during the initial days of the OAT.



The average product success rates for each of the data sets are summarized in Table A-1. The product success rate data show no significant change in performance between the baseline evaluation and the OAT.

A.3 Product Latency

The baseline product latency data for network traffic from the NCF to the field sites and for network traffic from the field sites to the NCF are summarized in Tables A-7 and A-8, respectively. The figures shown in the tables are the daily average product latencies expressed in seconds (s). Data are presented for a total of 30 days; however, PAMS data were not available between the dates of July 27 and August 3 and the baseline dates are not sequential.

The product latency data obtained during the OAT for network traffic from the NCF to the field sites and for network traffic from the field sites to the NCF are summarized in Tables A-9 and A-10, respectively. It should be noted that PAMS data were not available for all sites on January 11 and for BCQ from January 11 to January 16.

The network traffic from NCF to BCQ was essentially identical to the other sites. However, as discussed above, network traffic from BCQ to NCF was intermittent during both the baseline evaluation and OAT. The volume of traffic from BCQ to NCF was not sufficient to provide a reliable estimate of daily product latency and the product latency data for traffic from BCQ to NCF will not be considered.

Graphical analysis of the product latency data suggests that the system clocks at PBZ, LZK, and ABR were not properly synchronized with the AWIPS reference clock throughout the OAT. An NCF trouble ticket was opened following the OAT to address this issue. Representative data

showing this behavior are presented in Figure A-1. These data indicate the system clock at ABR drifted on the order of 1 second/day over the first 9 days of the OAT. Similar behavior was noted in the product latency data obtained for PBZ and LZK.

The results of ANOVA of the product latency data obtained during the baseline evaluation and the OAT suggest that each data set is distinct and should be considered separately.

The average product latencies are summarized in Table A-2. The figures shown in the table are the average daily product latencies expressed in seconds (s). The average daily product latencies are based on periods of time when the daily product latency was relatively stable. The ABR to NCF average product latency for the OAT is based on the data obtained after day 9, for example. The time periods exhibiting unstable clock behavior are indicated in Tables A-9 and A-10. The quantity Δ shown in Table A-2 is the time difference between the baseline average and the OAT average. Values for Δ are only displayed for cases where the probability that the data sets are distinct is greater than 99 %.

Table A-2: Average Daily Product Latency.

	Baseline (s)	OAT (s)	Δ^* (s)
OAT Sites			
NCF to ABR	11.83	10.95	0.88
ABR to NCF	11.14	9.63	1.51
NCF to FGF	12.80	12.27	0.53
FGF to NCF	11.31	8.98	2.38
NCF to BCQ	12.35	11.59	0.76
Control Sites			
NCF to PBZ	12.98	12.13	—
PBZ to NCF	10.04	9.53	0.51
NCF to LKZ	13.74	13.44	—
LKZ to NCF	11.80	10.20	1.60

*Time differences, Δ, are reported only for greater than 99 % confidence that the average values differ.

There is thus a greater than 99 % probability that the product latencies obtained during the OAT have been reduced from the baseline data for network traffic from the WFO sites, including the control sites, to the NCF. The product latency for traffic from the NCF to the OAT sites including BCQ is also reduced from the baseline. The control sites show no significant change for traffic from the NCF to the WFO sites, which suggests some improvement might be attributed to the MPLS WAN.

A.4 Discussion

No significant difference was measured in the product success rates for the baseline evaluation and OAT. A reduction in product latency was noted for network traffic from the WFO sites to the NCF over the baseline data for both the OAT and control sites. A reduction in product latency was also noted for network traffic from the NCF to OAT sites. These results demonstrate the product throughput of the MPLS WAN is on par with the existing frame relay WAN and there is no reduction in the product throughput using the MPLS WAN.

It is not clear these apparent changes in product latency can be solely attributed to the MPLS WAN. Two factors may have contributed to improved performance: 1) The weather was exceptionally mild and the volume of network traffic was low during the OAT; and 2) the OAT sites and control sites have undergone significant changes since the baseline data were obtained. Specifically, new data servers (DX) were installed at all sites and the AWIPS application software was upgraded to OB7.1 at ABR, FGF, MSR, LZK, and KRF and to OB7.2 at PBZ and BCQ. Most of the product latency is due to the message handling system rather than network bandwidth limitations; and, it thus seems likely, the changes in the system hardware and application software might have contributed to improved performance. It should also be noted that the measured time differences indicated in Table A-2 are of the order of the expected uncertainty in the AWIPS clock. A more thorough treatment of the data would require careful examination of the uncertainty of the AWIPS clock.

Table A-3: Baseline Product Success Rates: NCF to Sites (%).

Date	ABR	FGF	BCQ	PBZ	LZK
07/05/2006	100	100	100	100	100
07/06/2006	92.35	100	100	100	100
07/07/2006	100	100	100	97.89	100
07/08/2006	100	100	100	100	100
07/09/2006	100	100	100	100	100
07/10/2006	100	100	100	100	100
07/11/2006	100	100	100	100	100
07/12/2006	100	100	100	100	100
07/13/2006	100	100	100	100	100
07/14/2006	100	100	100	100	100
07/15/2006	100	100	100	100	100
07/16/2006	100	100	100	100	100
07/17/2006	100	100	100	100	100
07/18/2006	100	100	100	100	100
07/19/2006	100	100	100	100	94.18
07/20/2006	100	100	100	100	100
07/21/2006	100	100	100	100	100
07/22/2006	100	100	100	100	100
07/23/2006	100	100	100	100	100
07/24/2006	100	100	100	100	100
07/25/2006	100	100	100	100	100
07/26/2006	100	100	100	100	100
07/27/2006					
07/28/2006					
07/29/2006					
07/30/2006					
07/31/2006					
08/01/2006					
08/02/2006					
08/03/2006					
08/04/2006	100	100	100	100	100
08/05/2006	100	100	100	100	100
08/06/2006	100	100	100	100	100
08/07/2006	100	100	100	100	100
08/08/2006	100	100	100	100	100
08/09/2006	100	100	100	100	100
08/10/2006	100	100	100	100	100
08/11/2006	100	100	100	100	100

Table A-4: Baseline Product Success Rates: Sites to NCF (%).

Date	ABR	FGF	BCQ	PBZ	LZK
07/05/2006	100	100		100	100
07/06/2006	99.95	100	100	100	100
07/07/2006	100	100	100	99.98	100
07/08/2006	100	100		100	100
07/09/2006	100	100		100	100
07/10/2006	100	100		100	100
07/11/2006	100	100		100	100
07/12/2006	100	100		100	100
07/13/2006	100	100		100	100
07/14/2006	100	100		100	100
07/15/2006	100	100		100	100
07/16/2006	100	100		100	100
07/17/2006	100	100		100	100
07/18/2006	100	100	100	100	99.97
07/19/2006	100	100		100	100
07/20/2006	100	100		100	100
07/21/2006	100	100		100	100
07/22/2006	100	100		100	100
07/23/2006	100	100	100	100	100
07/24/2006	100	100		100	100
07/25/2006	100	100		100	100
07/26/2006	100	100		100	100
07/27/2006					
07/28/2006					
07/29/2006					
07/30/2006					
07/31/2006					
08/01/2006					
08/02/2006					
08/03/2006					
08/04/2006	100	100		100	100
08/05/2006	100	100		100	100
08/06/2006	100	100		100	100
08/07/2006	100	100		100	100
08/08/2006	100	100	100	100	100
08/09/2006	100	100	100	100	100
08/10/2006	100	100	100	100	99.98
08/11/2006	100	100	100	100	100

Table A-5: OAT Product Success Rates: NCF to Sites (%).

Date	ABR	FGF	BCQ	PBZ	LZK
01/08/2007	100	100	100	100	100
01/09/2007	100	100	100	100	100
01/10/2007	100	100	100	100	100
01/11/2007					
01/12/2007	100	100		100	100
01/13/2007	100	100		100	100
01/14/2007	100	100		100	100
01/15/2007	100	100		100	100
01/16/2007	100	100		100	100
01/17/2007	100	100	100	100	100
01/18/2007	100	100	100	100	100
01/19/2007	100	100	100	100	100
01/20/2007	100	100	100	100	100
01/21/2007	100	100	100	100	100
01/22/2007	100	100	100	100	100
01/23/2007	100	100	100	100	100
01/24/2007	100	100	100	100	90.50
01/25/2007	100	100	100	100	100
01/26/2007	100	100	100	100	100
01/27/2007	100	100	100	100	100
01/28/2007	100	100	100	100	100
01/29/2007	100	100	100	100	100
01/30/2007	100	100	100	100	100
01/31/2007	100	100	100	100	100
02/01/2007	100	100	100	100	100
02/02/2007	100	100	100	100	100
02/03/2007	100	100	100	100	100
02/04/2007	100	100	100	100	100
02/05/2007	100	100	100	100	100
02/06/2007	100	100	100	100	100
02/07/2007	100	100	100	100	100
02/08/2007	100	100	100	100	100
02/09/2007	100	100	100	100	100

Table A-6: OAT Product Success Rates: Sites to NCF (%).

Date	ABR	FGF	BCQ	PBZ	LZK
01/08/2007	100	100		100	100
01/09/2007	100	100		100	100
01/10/2007	99.98	100		100	100
01/11/2007					
01/12/2007	100	100		100	99.99
01/13/2007	100	100		100	100
01/14/2007	100	100		100	100
01/15/2007	100	100		100	100
01/16/2007	100	100		100	100
01/17/2007	100	100		100	100
01/18/2007	100	100		100	100
01/19/2007	100	100		100	100
01/20/2007	100	100		100	100
01/21/2007	100	100		100	100
01/22/2007	100	100		100	100
01/23/2007	100	100		100	100
01/24/2007	100	100		100	100
01/25/2007	100	100		100	99.72
01/26/2007	100	100	100	100	100
01/27/2007	100	100		100	100
01/28/2007	100	100		100	100
01/29/2007	100	100		100	100
01/30/2007	100	100		100	100
01/31/2007	100	100	100	100	100
02/01/2007	100	100		100	100
02/02/2007	100	100		100	100
02/03/2007	100	100		100	100
02/04/2007	100	100		100	100
02/05/2007	100	100	100	100	100
02/06/2007	100	100		100	99.96
02/07/2007	100	100		100	100
02/08/2007	100	100		100	100
02/09/2007	100	100		100	100

Table A-7: Baseline Product Latency: NCF to Sites (s).

Date	ABR	FGF	BCQ	PBZ	LZK
07/05/2006	12.10	12.77	12.57	19.68	13.50
07/06/2006	17.37	14.40	14.14	13.90	15.67
07/07/2006	11.08	12.30	11.85	12.47	12.86
07/08/2006	11.11	12.47	11.93	12.44	12.74
07/09/2006	11.00	12.32	11.75	12.37	12.72
07/10/2006	11.47	12.66	12.26	13.44	13.04
07/11/2006	13.59	14.07	14.08	13.66	14.74
07/12/2006	11.48	12.68	12.32	12.66	13.04
07/13/2006	11.53	12.65	11.95	12.74	14.02
07/14/2006	11.47	12.64	12.16	12.50	13.84
07/15/2006	11.31	12.48	12.01	12.57	13.62
07/16/2006	11.21	12.56	11.99	12.59	13.66
07/17/2006	11.60	12.68	12.48	12.79	13.71
07/18/2006	13.43	13.90	14.24	13.81	14.95
07/19/2006	13.10	13.57	13.71	13.41	16.46
07/20/2006	11.38	12.66	12.11	12.65	13.35
07/21/2006	11.35	12.53	12.11	12.63	13.28
07/22/2006	11.60	12.77	12.34	12.98	13.80
07/23/2006	11.26	12.72	12.16	12.60	13.02
07/24/2006	11.23	12.50	11.48	12.50	12.86
07/25/2006	12.22	13.08	13.34	12.98	15.26
07/26/2006	11.21	12.42	11.94	14.00	13.05
07/27/2007					
07/28/2007					
07/29/2007					
07/30/2007					
07/31/2007					
08/01/2007					
08/02/2007					
08/03/2007					
08/04/2006	11.40	12.56	11.88	12.24	13.54
08/05/2006	11.39	12.56	11.78	12.23	13.84
08/06/2006	11.44	12.64	11.75	12.23	13.55
08/07/2006	11.61	12.69	12.12	12.34	13.57
08/08/2006	11.43	12.79	12.16	12.24	13.54
08/09/2006	11.30	12.44	11.84	12.07	13.36
08/10/2006	11.68	12.76	12.13	12.30	14.11
08/11/2006	11.56	12.69	12.04	12.35	13.60

Table A-8: Baseline Product Latency: Sites to NCF (s).

Date	ABR	FGF	PBZ	LZK
07/05/2006	11.37	11.04	10.58	12.34
07/06/2006	10.76	10.99	9.66	11.96
07/07/2006	11.15	11.05	9.98	11.56
07/08/2006	11.27	11.50	10.11	11.29
07/09/2006	10.85	11.12	10.19	11.90
07/10/2006	11.13	11.04	10.37	12.32
07/11/2006	11.24	11.05	10.38	11.72
07/12/2006	11.17	10.94	10.78	11.55
07/13/2006	11.11	11.59	10.61	11.77
07/14/2006	11.27	10.88	10.56	11.96
07/15/2006	11.43	10.61	10.45	12.27
07/16/2006	11.13	11.35	9.65	11.92
07/17/2006	11.36	11.01	9.81	11.31
07/18/2006	11.24	11.23	10.01	11.19
07/19/2006	11.21	11.50	10.42	11.69
07/20/2006	11.10	10.89	10.30	12.16
07/21/2006	10.98	11.18	10.16	12.18
07/22/2006	11.04	11.14	10.31	12.50
07/23/2006	11.08	10.75	9.72	11.73
07/24/2006	11.20	11.54	9.44	11.57
07/25/2006	11.21	11.27	9.57	11.54
07/26/2006	11.26	11.17	10.06	11.46
07/27/2006				
07/28/2006				
07/29/2006				
07/30/2006				
07/31/2006				
08/01/2006				
08/02/2006				
08/03/2006				
08/04/2006	11.34	12.24	9.90	11.87
08/05/2006	10.95	11.82	9.39	11.63
08/06/2006	10.88	11.50	9.72	12.59
08/07/2006	11.05	11.27	10.06	11.00
08/08/2006	10.90	11.07	9.90	10.97
08/09/2006	11.08	11.82	9.69	11.51
08/10/2006	11.43	12.78	9.85	12.28
08/11/2006	11.04	11.85	9.74	12.08

Table A-9: OAT Product Latency: NCF to Sites (s).

Date	ABR	FGF	BCQ	PBZ	LZK
01/08/2007	7.99*	11.89	12.33	12.44*	15.53*
01/09/2007	6.27*	11.48	11.84	12.05*	13.57*
01/10/2007	5.30*	11.34	12.03	11.38*	12.89*
01/11/2007					
01/12/2007	3.14*	11.28		10.24*	13.27*
01/13/2007	2.01*	11.37		9.60*	13.44*
01/14/2007	1.08*	11.36		8.95*	15.68*
01/15/2007	0.18*	11.36		8.46*	14.41*
01/16/2007	2.39*	11.43	13.90	8.85*	13.46
01/17/2007	10.39	11.30	11.89	12.31*	13.27
01/18/2007	10.50	11.92	11.99	10.87*	13.65
01/19/2007	10.52	11.92	11.49	8.36*	13.26
01/20/2007	10.53	11.81	11.19	5.71*	13.48
01/21/2007	11.06	11.73	11.52	3.62*	13.77
01/22/2007	11.48	11.95	11.90	5.69*	14.04
01/23/2007	10.87	12.05	11.38	11.64*	13.57
01/24/2007	10.86	11.70	11.51	11.19*	13.35
01/25/2007	11.03	11.76	11.61	11.78*	13.44
01/26/2007	10.80	11.98	11.32	11.99*	13.01
01/27/2007	10.78	11.80	11.28	12.23*	12.93
01/28/2007	10.86	11.72	11.39	13.48*	14.55*
01/29/2007	10.77	11.98	11.28	15.04	16.07*
01/30/2007	10.56	12.10	11.32	16.30	18.13*
01/31/2007	10.72	12.19	11.56	12.53	13.98*
02/01/2007	11.42	12.06	12.38	12.71	14.11*
02/02/2007	10.87	12.35	11.65	12.54	11.36*
02/03/2007	11.23	12.29	12.00	12.75	10.44*
02/04/2007	10.77	11.93	11.56	12.25	10.04*
02/05/2007	11.61	15.67	12.08	11.83	12.76*
02/06/2007	11.54	12.67	11.44	12.05	13.72*
02/07/2007	11.12	12.17	10.84	12.32	12.62*
02/08/2007	11.11	12.58	10.90	11.97	13.22*
02/09/2007	11.43	13.88	11.12	10.35	14.71*

*Data not considered due to unstable AWIPS clock.

Table A-10: OAT Product Latency: Sites to NCF (s).

Date	ABR	FGF	PBZ	LZK
01/08/2007	14.26*	10.61	9.90*	12.78*
01/09/2007	14.01*	9.52	10.07*	10.33*
01/10/2007	14.95*	9.42	10.57*	9.99*
01/11/2007				
01/12/2007	16.89*	9.87	12.15*	10.32*
01/13/2007	17.93*	9.74	12.89*	10.52*
01/14/2007	18.72*	9.84	13.53*	14.40*
01/15/2007	19.70*	9.72	14.31*	10.80*
01/16/2007	17.41*	9.87	12.79*	10.13
01/17/2007	9.40	9.05	9.32*	10.43
01/18/2007	9.39	9.11	10.85*	10.41
01/19/2007	9.61	8.89	13.31*	10.09
01/20/2007	9.47	9.01	15.63*	10.22
01/21/2007	9.51	9.10	18.01*	10.13
01/22/2007	9.54	9.13	18.27*	9.95
01/23/2007	9.70	9.14	9.69*	14.58
01/24/2007	9.44	8.94	10.24*	10.41
01/25/2007	9.41	9.18	10.07*	10.89
01/26/2007	9.57	9.03	9.54*	10.41
01/27/2007	9.61	9.21	9.45*	10.65
01/28/2007	9.72	9.02	8.14*	9.42*
01/29/2007	9.74	8.88	6.70	6.83*
01/30/2007	9.66	8.79	5.23	7.13*
01/31/2007	9.62	9.02	9.21	10.70*
02/01/2007	9.44	8.95	9.52	10.96*
02/02/2007	9.42	8.88	9.08	11.98*
02/03/2007	9.01	8.78	9.03	14.22*
02/04/2007	9.44	8.89	9.30	13.00*
02/05/2007	11.28	9.32	9.51	10.32*
02/06/2007	9.56	8.92	9.63	10.20*
02/07/2007	9.62	9.24	9.64	10.24*
02/08/2007	9.70	8.72	9.41	10.85*
02/09/2007	10.17	8.38	10.95	10.21*

*Data not considered due to unstable AWIPS clock.

Attachment B MPLS WAN Outage

An MPLS WAN outage occurred on Monday, February 5, during scheduled maintenance activities. The time-line for the outage is shown in Table B-1.

Table B-1: MPLS WAN Outage Time-line.

Time	Action
1450z	All OAT sites on dial backup (ADTRAN).
1500z	Planned maintenance of Silver Spring customer edge (CE) router.
1546z	ANCF's router log indicates the connection to the CE router is down.
1609z	NCF began receiving ITO alarms with MTA products queuing at surrounding WFO's.
1615z	NCF established a second ISDN connection to each of the RFC's to increase bandwidth. The timeliness of product transmission is still in issue
1625z	Contacted NOAAnet support for a status. CIO14 having problems with the new IOS
1630z	RFC OAT sites, as well as the spoke WFO's continue to have MHS products queuing up. KRF and MSR traffic is moved to the FR WAN.
1637z	Both KRF and MSR have been taken off ADTRAN and passing operational traffic over FR WAN. BCQ, FGF and ABR remain on dial backup.
1655z	MHS product backup has settled.
1712z	NOAAnet support contacts NCF with a status. Unable to run with the new IOS and they've reverted back to the original IOS.
1719z	NCF took ABR, BCQ and FGF off of dial backup. Operational traffic running over MPLS.
1729z	NCF moved operational traffic back to MPLS at KRF/EAX.
1736z	NCF moved operational traffic back to MPLS at MSR/MPX.